Accounting for Real-Life Conditions in Mini-Split Heat Pump Savings

Findings from a Billing Analysis

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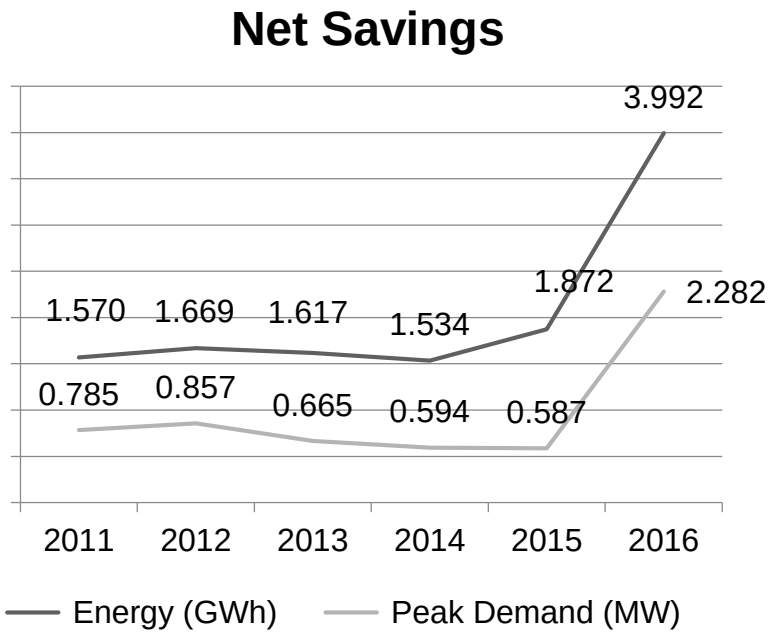
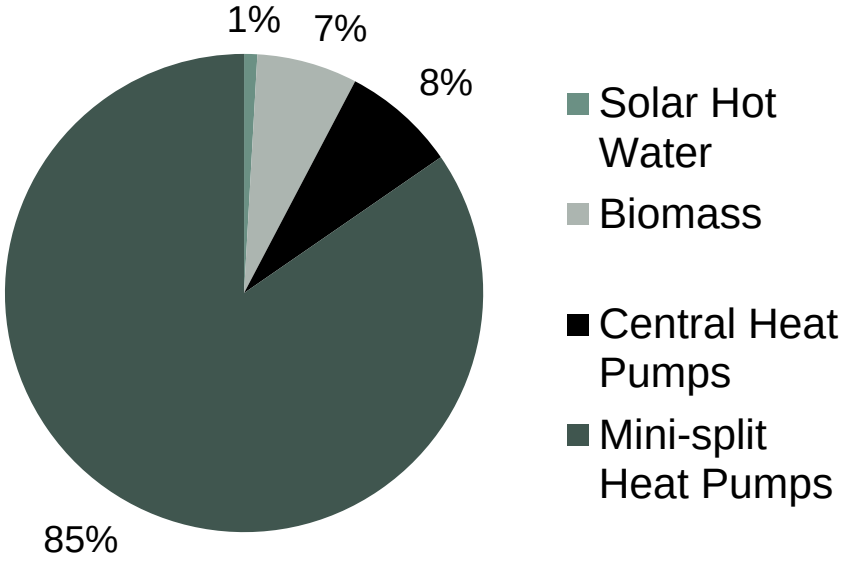
Our Problem in Two Graphs

- Green Heat, a residential heating program by Efficiency Nova Scotia





Solutions in Technical Literature

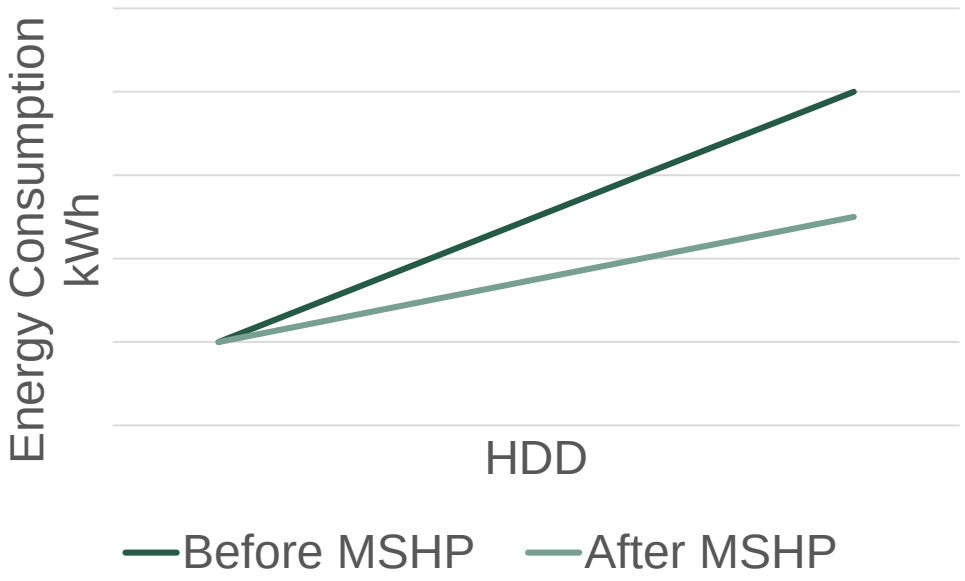
$$ES_{kWh} = \begin{matrix} HC * \left[\frac{1}{HSPF_{base}} - \frac{1}{HSPF_{ee}}\right] * EFLH_h + \\ CC * \left[\frac{1}{SEER_{base}} - \frac{1}{SEER_{ee}}\right] * EFLH_c \end{matrix}$$

- Most jurisdictions use an EFLH formula
- EFLH values based on: AHRI standard, weather bin analysis, energy modeling
- Metering studies seem to indicate that real operating conditions result in lower EFLH than anticipated.

Our Solution: Billing Analysis

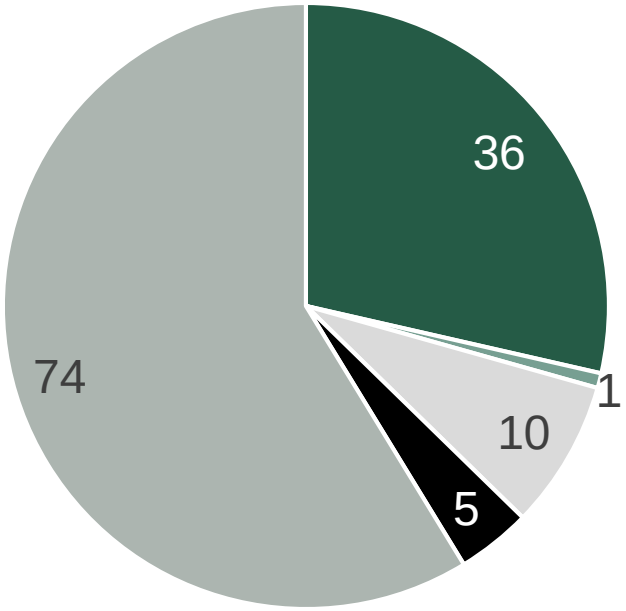
- Possible because MSHPs replace electrical resistance heating
- Based on comparing pre and post-installation periods

$$CONS = \alpha + \beta \times HDD + \varepsilon$$



Sorting Out Data

- Sufficient data for 126 participants
- Using statistical criteria to exclude biased data



- Non-statistically significant coefficient β for either the pre or post period
- Negative daily base consumption constant α
- Adjusted R2 below 0.65
- Outlier savings value (beyond 2 times standard deviation)
- Valid results

Findings: Average Savings

- Savings calculated in absolute or per installed capacity

	Energy Savings	Energy Savings per Installed Capacity
Mean	3,671 kWh	0.180 kWh/Btu/h
Standard Deviation	3,150 kWh	0.147 kWh/Btu/h
90% Confidence Interval	±601 kWh	±0.028 kWh/Btu/h
Relative Uncertainty	±16.4%	±15.6%

Findings: Impact of Secondary Systems

	Energy Savings		Energy Savings per Installed Capacity	
Secondary N-Elect. System?	YES	NO	YES	NO
n	27	47	27	47
Mean	2,800 kWh	4,170 kWh	0.124 kWh/Btu/h	0.212 kWh/Btu/h
Standard Deviation	3,630 kWh	2,760 kWh	0.148 kWh/Btu/h	0.139 kWh/Btu/h
90% Confidence Interval	±1,190 kWh	±660 kWh	±0.048 kWh/Btu/h	±0.033 kWh/Btu/h
Relative Uncertainty	±42%	±16%	±39%	±16%

Findings: Comparing Savings and EFLHs

$$EFLH_h = \frac{ES_{kWh}}{HC * \left[\frac{1}{HSPF_{base}} - \frac{1}{HSPF_{ee}}\right]}$$

Average Energy Savings	Average Pre-Installation Variable Elect. Consumption	% of Variable Elect. Consumption Saved	EFLH Heating
3,671 kWh	12,186 kWh	30%	890 h

- Average $HSPF_{ee}$: 10.63 → Equivalent to 67% reduction in energy consumption for heating over electrical resistance

Conclusions

- Method successful in improving previous estimate of energy savings values
- Provided more evidence that EFLH methods overestimated savings
- Showed impact of non-electrical secondary heating systems on savings

Thank you!

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